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DELTA 22
FLASH FLIGHT REPORT
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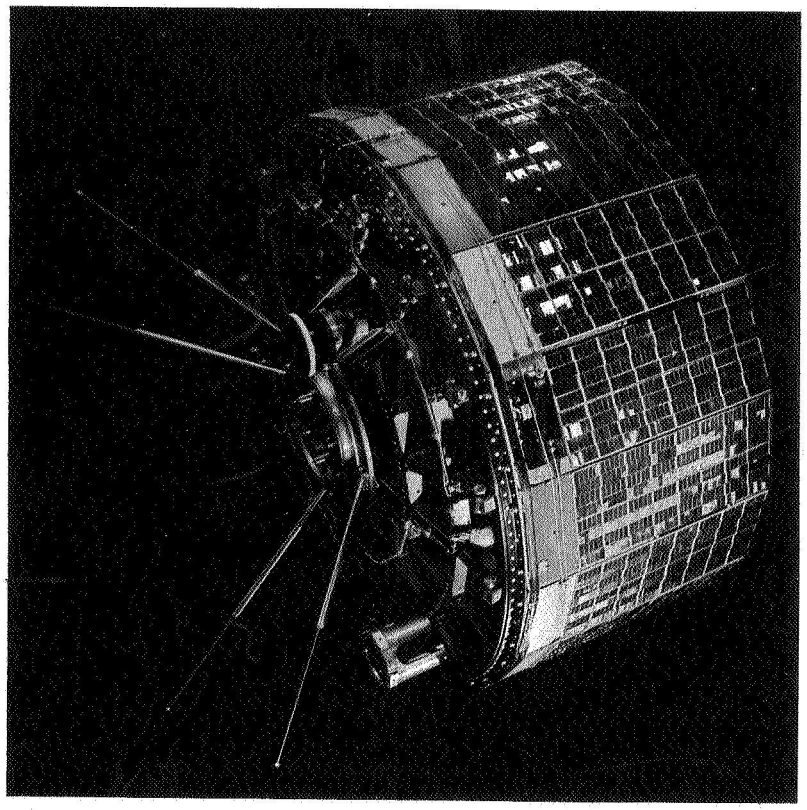

prepared by

FIELD PROJECTS BRANCH
ATLANTIC MISSILE RANGE

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

TIROS H (VIII)

PROJECT DELTA 22

A53

TIROS H

*FLASH FLIGHT REPORT

December 21, 1963

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NOTE: Because of the short period of time allowed for the publication of this report and the lack of some downrange and local data for review, some information may be incomplete or in error. The comprehensive Field Flight Report, which will be published in about 21 days, will include a detailed analysis of all data.

GODDARD SPACE FLIGHT CENTER
FIELD PROJECTS BRANCH
ATLANTIC MISSILE RANGE

DELTA 22 FLASH FLIGHT REPORT

AIR FORCE MISSILE TEST CENTER TEST NUMBER 5332

1.0 SUMMARY OF TEST

The Delta 22 vehicle, consisting of three stages (371/20007/20008) and the A-53 Tiros H spacecraft was launched on December 21, 1963 at 0430 hours, 00.103 seconds EST from Complex 17, Pad B. First and second stage performance was slightly above nominal. Third stage performance was nominal as indicated by preliminary orbital and doppler predictions. The Tiros H spacecraft was injected into the proper orbit.

The weather conditions over Cape Kennedy during the Delta 22 launch were generally as predicted. The ceiling was 3,000 feet with three tenths cloud cover. There was a maximum wind shear of five knots per thousand feet and a maximum wind of 90 knots. Surface winds were from the Southeast at 10 to 18 knots. Visibility was 10 miles with no obstructions. Temperature at sea level was 55 degrees F.

2.0 LAUNCH PREPARATIONS

2.1 F-6 Day Operations

The F-6 Day Acceptance Test started at 0930 EST on December 10, 1963. This test included the RF systems checks normally conducted on F-10 Day. An analysis of the tests were made and the following anomalies were found:

a. On the tests with the tower around the missile the range could not read out the beacon due to excessive countdown. When the tower was removed the range was able to read out the beacon.

b. During the internal run, MECO was late because the GSE relay (K3704), which actuates the depressurization solenoid, did not actuate when depressed the first time. Investigation showed the relay was intermittent. This relay was replaced.

c. One of the third stage separation lights on the GSE bolt box simulator did not fire during the internal run. Troubleshooting after the run revealed a loose GSE connection.

d. On the internal run, noise was noticed on the pitch actuator second stage. This actuator was replaced; however the replacement actuator did not pass hysteresis tests. A second replacement was installed but engine centering could not be accomplished with this actuator installed. Since no replacement actuators were available the valve of the first actuator mentioned above was mated with the potentiometer of this second replacement actuator and this combination assembly was satisfactorily installed and checked out on the missile.

e. During these tests RF interference was noted in the second stage yaw engine position. This interference has not been duplicated in subsequent tests and has been attributed to poor bonding of the electronics package door during this test.

f. During these tests the yaw drift rate on the first stage hermetically sealed integrating (HIG) gyro was excessive. After these tests, the controls electronics assembly (CEA) was returned to the E lab where the gyro was replaced.

g. During the internal run, the stop pitch command (D1) was not sent to missile electronics from the Bell Telephone Laboratory (BTL) guidance package. Subsequent tests revealed the guidance package would not properly encode the stop pitch command from the BTL ground station. The BTL guidance package was, therefore, replaced. During replacement, connector P800 was installed incorrectly and the insert was punctured. This was deemed acceptable for use.

h. After this test, the second stage gyro package was replaced because the former package contained gyros with magnets mounted in the spin motor rotors (used for spin motor monitoring on other than Delta programs), and the magnets have reportedly caused gyro failures by becoming unmounted. The replacement package contained the standard Delta purchased gyros which have a solid rotor.

2.2 F-3 Day Operations

The F-3 Day All Systems Test commenced at 1230 EST on December 13, 1963. Prior to these tests the following items were noted:

a. The fuel pump inlet temperature probe checked bad and was replaced on December 12, 1963.

b. The facility fill and drain valve had a leak around the head gasket. The gasket was replaced and the leak stopped.

An analysis of the F-3 tests was made and the following anomalies were found:

a. The triaxial accelerometer in the second stage was not reading correctly. A broken wire was found (pin D, J602) in the vehicle and was replaced.

b. Prior to the external run, a second stage hydraulic line was found to have interference with the accumulator. This line was wrapped with teflon tape.

c. At the start of the internal run, flight lock-in was not received. This was a result of BTL not depressing the guidance reset button at the end of the external run. The arm switch was reset and after engine-start was depressed, flight lock-in was received.

d. During this test, it was noted that the first stage pitch gyro exhibited a nonlinear movement when torqued from its null position. This was not fully resolved until

after the F-1 electrical checks on December 16, 1963. At this time the CEA was returned to the E Lab for pitch gyro replacement.

2.3 F-1 Day Operations

The F-1 Day countdown operations began at 0730 EST on December 16, 1963. Electrical checks were satisfactorily completed; however, after completion the CEA was returned to the E lab for pitch gyro replacement for the problem noted during F-3 Day operations (See Section 2.2, paragraph d). This replacement made launch rescheduling necessary. The launch, originally scheduled for December 17th, was changed to December 18, 1963.

2.4 Rescheduled F-1 Day Operations

After replacement of the first stage pitch gyro, the CEA was returned to the missile at 2300 EST on December 17th and checkout was started at that time. The following problems were noted during this checkout:

a. The yaw vernier engines could not be electrically centered within the prescribed limits. It was necessary to mechanically recenter the yaw vernier actuator potentiometers, after which electrical centering was satisfactorily accomplished. Several electrical connections on the vernier engines were opened to accomplish this.

b. It was noted during the BTL gain checks (first test conducted with telemetry on after return of the CEA to the vehicle) that the roll gyro drift rate was excessive.

c. On the next telemetry turn-on to investigate the roll gyro drift problem, many telemetry channels gave erroneous readings. Troubleshooting revealed the -25 v dc potentiometer negative voltage was 0 v dc, thus affecting all flight control functions and explaining all the erroneous readings. Further troubleshooting revealed Pin C on P94, Pitch #1 vernier engine actuator connector shorted to the connector shell. This short developed between the two telemetry runs as this connector was being re-safety wired from the opening necessary in problem (a.) above. Connector P94 and the aforementioned actuator were replaced.

   The CEA was returned to the E lab for roll gyro and power supply replacement (It was felt the above short could have damaged power supply). These replacements again forced launch rescheduling to December 20, 1963.

   The CEA was returned to the launcher 0730 EST, December 18, 1963. All prechecks were satisfactorily accomplished by 1700 EST. The rescheduled F-1 Day Electrical Tests commenced at 0700 EST, December 19, 1963 and were completed without incident.

2.5 F-0 Day Operations

The F-0 Day countdown began at 1750 EST on December 19, 1963. The countdown proceeded normally until RF systems checks at 0005, December 20, 1963.

While conducting second stage command destruct checks, an abnormal drop was noted on the Stage II instrumentation battery which powers this CDR. Investigation revealed a wire path of slightly over one ohm across this battery when destruct was sent. This low resistance path was through the first stage destruct relay, as the first stage CDR was off for this test. To further investigate this anomaly, the launch scheduled for 0430 EST on December 20, 1963, was cancelled and rescheduled for 0430 EST on December 21st. During troubleshooting on the above problem the C-band beacon began to trigger randomly. The beacon was returned to the RF lab where improper operation was confirmed. It then was replaced and a special test on December 20th was satisfactorily conducted on the replacement beacon.

The investigation on the low resistance path across the second stage instrumentation battery revealed an improperly wired second stage range safety J-box. This J-box was properly rewired and the first and second stage destruct relays were replaced since current contact ratings had been exceeded. An inspection and test of missile wiring in this high current patch showed missile wiring had not been damaged. A special test was conducted with the range at 2030, December 20th, after rewiring of the J-box and replacement of the relays. All operations were normal during this test.

2.6 Rescheduled F-0 Day Operations

The F-0 Day countdown began at 2200 EST, December 20, 1963. Second stage fueling, second stage oxidizer loading and first stage fueling and fairing installation had been completed on the previous countdown. At approximately 2300 EST the 400 cps ground power from the main generator was lost and the standby generator was used until the brushes were replaced in the main generator. Also power was lost in the Hangar AE and M telemetry ground stations for approximately 30 minutes. However, this occurred at a time (approximately 0100 EST) not affecting countdown operations.

Terminal count was initiated at 0355 EST (T-35) and proceeded normally to liftoff with no major problems.

3.0 TRAJECTORY

3.1 The First Stage Impact Charts indicated a three sigma lateral deviation to the right of nominal from liftoff until guidance initiation at T+90 seconds. After guidance correction, the vehicle position was on nominal until MECO. The first stage impact point was approximately 80 nautical miles downrange of the expected point. The vehicle crossed over from higher to lower than nominal at T+60 seconds. The present position charts indicated that the first stage was two nautical miles low in the pitch plane and 1.5 nautical miles to the right of nominal in the azimuth plane.

3.2 Second Stage

The second stage impact chart indicated that the vehicle was approximately five nautical miles below nominal and about 2.5 nautical miles to the right of the nominal line at SECO.

The second stage IP was approximately 65 natuical miles downrange of nominal.

4.0 SEQUENCE OF EVENTS

The following event times are given in seconds after liftoff:

EVENT	EXPECTED	ACTUAL
Liftoff	T+0	T+0
Start Roll	T+2	T+2
Stop Roll	T+9	T+9
Pitch #1	T+10	--
Uncage Stage II Roll	T+14	T+14
Pitch #2	T+30	T+30
Pitch #3	T+70	T+70
Enable BTL	T+80	--
Pitch #4	T+90	T+90
Gain Change	T+90	T+90
BTL Guidance	T+90	--
Arm Bus	T+111	T+115.5
Stop Pitch	T+130	T+130.1
Enable MECO	T+139	T+136
MECO	T+146.2	T+145.1

NOTE: Because the second stage programmer is started by MECO, all second stage programmer events are referenced to the actual MECO time.

Seq. #1 (MECO)	M+4	M+4
Yaw #1	M+6	M+6
Stop Yaw #1	M+17	M+17

EVENT	EXPECTED	ACTUAL
Seq. #2	M+19	M+19.9
Pitch #1	M+21	M+21
Stop Pitch	M+147.6	M+147.7
SECO (BTL)	M+163.2	M+155.5
Seq. #3	M+169	M+169
Pitch #2	M+185	M+185
BTL Off	M+218.2	M+219.5
Stop Pitch #2	M+285	M+285
Yaw #2	M+287	M+287
Stop Yaw #2	M+347	M+347
Seq #4	M+476.5	M+476.5
Seq #5	M+478.5	M+478.5
Seq #5 BU	M+480.5	M+480
Stage III Ign.	M+491.5	
Stage III B. O.	M+533.5	Information not received in time for this printing
S/C Separation	M+1141.5	
Release YO	M+1143.5	

5.0 PROPULSION

5.1 First Stage

Preliminary data indicates slightly above nominal first stage performance. Total liftoff sea-level thrust was 159,500 pounds and the total steady state thrust level was 174,000 pounds. Turbopump speed and GG LOX injection pressure reflect this thrust level. First stage burning time to MECO was 145.1 seconds with an apparent LOX depletion. Propellant utilization was indicated to be 99.6%.

Hydraulic supply pressure was 3160 psia and return pressure was 90 psia. System operation appears normal.

Vernier engine performance was normal with an engine chamber pressure of 365 psia and a solo burn time of 13 seconds.

Both pump inlet pressures and main tank pressures appear normal. Turbine inlet temperature trace was not available, probably due to a transducer malfunction.

5.2 Second Stage

Second stage performance was nominal with a steady state thrust of 7503 pounds at ignition plus 50 seconds; burn time was 151 seconds. Predicted Detailed Test Objectives (DTO) burning time was 159.6 seconds. Tail-off appears normal at ignition plus 115 seconds and helium regulator operation throughout the flight was satisfactory. Propellant utilization was approximately 90%.

Helium sphere pressure was 1630 psig at booster liftoff and 1610 psig at second stage ignition. HGA ignition occurred on time and operation was normal.

All parameters were smooth during steady state operation and shutdown.

Oxidizer probe operation was normal. Boil-off of the oxidizer remaining in the TCA jacket after SECO uncovered the probes approximately 26 seconds after SECO.

Retro system pressure was steady throughout flight at a level of 2275 psia. Gas expulsion at retro command was smooth and rapid.

Hydraulic system performance was nominal at a pressure level of 1030 psia, until turned off.

6.0 GUIDANCE AND CONTROLS

6.1 First Stage

The First Stage Controls System performed satisfactorily. Liftoff transients were small and easily damped.

The first stage pitch and roll programs occurred as scheduled and were of normal magnitude. Vehicle response to these commands was normal.

In the Mach 1 region (approximately T+38 seconds) there was a roll attitude excursion of +2.5 degrees that was reflected in the vernier pitch positions such that they were driven off their telemetry limits. It is possible that this condition was caused by fin misalignment. Maximum roll attitude error at maximum Q was+3.3 degrees. The controls system adequately damped these errors.

Maximum Q effects as reflected in the pitch and yaw main engines were +2.03 degrees in pitch and -1.13 degrees in yaw.

The second stage roll gyro error signal just prior to first stage/second stage separation was +0.49 degrees, indicating a much better first stage roll gyro drift rate than experienced in the last two Delta flights.

BTL started steering at approximately T+88 seconds. Initial steering orders were pitch down and yaw left. Response of the vehicle to these orders was normal. The last first stage BTL commands occurred at T+136 seconds. No abnormal disturbances were encountered at gain change or MECO.

Inverter voltage was steady at 114.8 volts. Missile battery was good at 27.4 volts. Actuator pot positive was 24.8 volts; actuator pot negative was 24.7 volts.

The second stage was armed by G switches at 29.6 seconds before MECO.

6.2 Second Stage

6.2.1 Powered Flight

At first stage/second stage separation, attitude errors were +0.44 degrees in pitch and +.18 degrees in yaw. All programmed events occurred on time.

Thrust misalignment during second stage powered flight was less than 0.1 degrees in both pitch and yaw. Response to the commanded yaw and pitch program rates was good. No abnormal disturbances resulted from fairing ejection. BTL steering orders, as received by the vehicle, appeared to be of low order and vehicle response was normal. Engine battery was 29.3 volts during powered flight rising to 31.3 volts after SECO. Control battery at loss of signal was 28.9 volts. Inverter voltage was steady at 14.5 volts.

SECO was commanded by BTL at 09:35:00.8Z (4:35.00.8 EST). BTL open loop steering commands were -0.6 degrees in pitch and -0.3 degrees in yaw. Vehicle response to these commands was normal.

6.2.2 Coast Flight

All the functions initiated by the second stage programmer were on time and of the proper magnitude.

Coast control was initiated at SECO and damped the BTL open loop transients. At no time prior to spinup did the gyro errors exceed their preset dead zones.

The spin rate at second-stage/third-stage separation was 128. At this time the vehicle was 0.36 degrees down and 0.2 degrees to the right; moving at approximately 0.78 degree/sec. in pitch and 0.29 degree/sec. in yaw. The pitch rate was higher than that usually experienced and could be attributed to misalignment (unsymmetrical thrust pattern) of the spin rockets. After second-stage/third-stage separation transients normal limit cycles were achieved in all control axes.

7.0 DATA AND INSTRUMENTATION

7.1 Optics

There were 66 mainland cameras committed to Test 5332. All but one of the cameras were reported to have operated satisfactorily at actual liftoff.

7.2 Radar and Radar Beacons

Radar coverage was excellent, with both Cape and Patrick radars having coverage to T+780 seconds. Bermuda had excellent coverage extending from T+332 to T+963. Data from Bermuda was processed at Goddard to give second stage instantaneous impact prediction and present position data, displayed at Mercury Control Center.

The C-band beacon was changed on the first F-0 day (Dec 20th) because of apparent noise triggering possibly due to excessive sensitivity.

7.3 Telemetry

7.3.1 Transmitters

The first stage transmitter performed as expected with very little flame ionization loss at Hangar AE, and none at Tel 2.

The second stage transmitter appeared to have a low output during flight because both NASA and DAC ground stations experienced numerous dropouts. The reduced power apparently did not affect the range ground stations since they have better antenna systems. No data appears to have been lost due to this apparent trouble.

7.3.2 Ground Station Coverage

First stage coverage was complete during powered flight. Second stage coverage was complete to re-entry according to the range preliminary estimate of data coverage. The New Boston Satellite Tracking Center and an aircraft near the re-entry area completed the data coverage for the second stage. No report is presently available from Newfoundland, Wallops Island or Bermuda.

ELSSE coverage was reported satisfactory with coverage through T+709 seconds.

7.4 Command/Destruct

No command/destruct measures were necessary for this launch.

7.5 Vehicle Instrumentation

The 20 cycle instrumentation was placed on this vehicle. Two first stage telemetry channels apparently malfunctioned. They were the turbine inlet temperature and the main engine gimbal point axial accelerometer. All other channels appeared nominal.

8.0 SPACECRAFT

The F-1 day operations began at 0730 EST on December 16th. The F-1 day spacecraft test began at 0945 EST and was completed without incident at 1030 EST.

As a result of vehicle gyro problems, the launch scheduled for 0430 EST, December 17th was scrubbed and rescheduled for 0430 EST, December 18th.

The F-1 day test was rerun on December 17th 1963 with the spacecraft test beginning at 0800 EST. This test was completed with no problems at 0845 EST. The spacecraft was judged ready for launch. The launch was again scrubbed for vehicle problems and rescheduled for 0430 EST, December 20, 1963.

The F-1 day test was run for the third time on December 19. The spacecraft test began at 0700 EST and was completed at 0740 EST. The spacecraft was again judged ready for launch.

The F-0 day launch countdown was initiated at 1650 EST with spacecraft checks beginning at 1655 EST. This test was completed at 1850 EST. During this test interference on the Tiros command frequency caused a rerun of the Camera #1 remote cycle, thus adding approximately one half hour to the test time. All mobile transmitters on the Cape were advised not to use this frequency and the interference did not reappear. It was noted that the command transmitter in the Tiros checkout run had drifted slightly off frequency. The transmitter was readjusted and caused no more problems.

The third stage ordnance installation was begun at 1900 EST and was completed at 2100 EST. The smoke shield was installed and the spacecraft final preparations were completed at 2220 EST. The fairing installation was then begun and was completed at 2320 EST. The spacecraft final checkout test was completed at 2350 EST and the spacecraft was determined to be ready for launch. The launch was scrubbed at 0520 EST on December 20th due to a command destruct problem, and rescheduled for 0430 EST on December 21st. The fairing was not removed during this twenty four hour hold and all third stage ordnance was left installed and shorted in the second stage. The only exception was the fairing separation bolt squibs which were removed.

The F-0 countdown was initiated at 2200 EST on December 20th with the reinstallation of the fairing separation bolt squibs. The final spacecraft test was begun at 2305 EST and completed at 2325 EST with no problems. The spacecraft was again determined ready for launch. The spacecraft telemetry beacons were turned on at 0350 EST. The terminal countdown began at 0355 EST and proceeded without any holds to T-0 and liftoff at 0430:00.24 EST. The spacecraft signal appeared normal from pre-liftoff to T+760 seconds at the Cape Kennedy Minitrack Station. The signal was lost over the radio horizon just after third stage burnout. All events occurred on time.

The Minitrack Station at Winkfield, England acquired the spacecraft on schedule and confirmed separation from the third stage, and despin to 10 rpm. The PMR Tiros station acquired the satellite and confirmed that a successful orbit had been established. Picture readouts of camera #1 indicated proper operation in the direct mode, although pictures were dark due to the earth being in darkness below. Some sunlight reflection from the spacecraft antennas was noted.

Both spacecraft beacons are operating properly at this writing (Spacecraft in third orbit). Successful readout of Camera #1 in the remote mode has not yet been accomplished. The first test of the APT Camera will be performed during orbit #4. An attempt will also be made to readout Camera #1 remote sequence during the fourth orbit.

9.0 SATELLITE TRACKING STATION

The Tiros H spacecraft 136.23 mc transmitter was used as a source for doppler measurements. This transmitter was tracked from liftoff to T+744 seconds when it was lost over the radio horizon. Frequency at liftoff was 136.231714 mc. Doppler data indicated very close to nominal velocity increment from all three stages; however, SECO occurred approximately nine seconds earlier than nominal and velocity decrease during the coast flight was greater than nominal.

The following event times were measured from doppler data:

EVENT	EST
Liftoff	0430:00.24
MECO	0432:25.05
Fairing Eject	0432:44.2
SECO	0435:00.5
Spinup	0440:22.0
Third Stage Ignition	0440:37.5
Third Stage Burnout	0441:16.75

Spin rate measured from AGC records showed 129 rpm at spinup and 132 rpm at third stage burnout.

The spacecraft was injected into orbit and was given the number 1963 54A. Preliminary calculation of orbit parameters were:

	BTL	AMR	GODDARD
Apogee	387 n. miles	394.7 n. miles	406.9 n. miles
Perigee	384 n. miles	360.3 n. miles	378.2 n. miles
Inclination	58.55 degrees	58.76 degrees	58.5 degrees
Period	98.6 minutes	98.4 minutes	99 minutes

The spacecraft signals were acquired on the first pass at the predicted time.

10.0 PAD DAMAGE

Only normal pad damage was incurred.